

SPECIFICATION

TITLE

"ARRANGEMENT AND METHOD FOR DATA FOLLOW-UP FOR WARMUP CYCLES OF INK JET PRINT HEADS"

BACKGROUND OF THE INVENTION

The present invention is directed to an arrangement for data follow-up for a warmup cycle of an ink jet print head. The invention is utilized in ink jet printer devices, for example in a postage meter machine with an ink jet print head, a printing station of a mail processing machine or other printer devices.

Field of the Invention

German Patentschrift 196 05 015 (United States Patent No. 5,949,444) discloses a printer device of the JetMail® postage meter machine in detail. With a non-horizontal, approximately vertical letter transport, a franking imprint is implemented with an ink jet print head stationarily arranged in a recess behind a guide plate. A trigger sensor for the printing process is arranged shortly before the recess for the ink jet print head, which recognizes the start of the letter and interacts with an incremental sensor for path control. The printing process is triggered by a transmitted light barrier of the JetMail® postage meter machine (European Patent 901 108). The leading edge even of pieces of mail that are especially thick is thus unambiguously recognized. Further optical sensors for recognizing a mail jam and for path control are also utilized in the JetMail® device. In addition to these sensors, at least one sensor for sensing a print block of the print head is utilized, such as a heating resistor, this being likewise connected to the postage meter machine control via an internal interface circuit of the postage meter machine. An internal postage meter machine interface circuit is disclosed in European Patent 716 398 (United States Patent No. 5,710,721). For example, the print block

contains three ink printing modules. In conformity with an embodiment disclosed in European Application 713 776 (United States Patent No. 5,757,402), the ink printing modules are arranged between identically constructed circuit modules, the latter respectively carrying a heating resistor and a sensor. In order also to assure a high printing quality of the JetMail® postage meter machine even given a low ambient temperature, the print block, and thus the ink as well, are preheated to a predetermined temperature. Printing is only allowed within a specific temperature range, since the temperature of the ink has a considerable influence on the droplet formation during the ink ejection. When the ambient temperature lies at a temperature $T_{\text{error}} = 0^{\circ}\text{C}$ below the minimum operating temperature $T_{\text{min}} = 32^{\circ}\text{C}$ of the JetMail®, damage to the print head can occur due to excessively large temperature differences during heat-up. The printing quality becomes poorer above the maximum operating temperature $T_{\text{max}} = 50^{\circ}\text{C}$ of the JetMail® system. In both instances, at least one error message is generated. There are thus competing considerations between assuring a high print quality and achieving an immediate readiness of the printer device.

Other ink jet printers or postage meter machines with ink jet printer technology, for example with bubble jet technology, also must reach a predetermined operating temperature before the print block or the printer is enabled for printing. A sensor constantly measures the temperature in the ink print head. The specific warmup data are redetermined for each ink cartridge every time the device is turned on. A repeated spray-rinsing is thereby cyclically implemented and a large ink volume is thus wasted. For the purpose of an ink spraying, it is necessary to electrically heat a heating resistor arranged close to a nozzle such that some of the water of the aqueous ink suddenly evaporates (bubble jet principle). The ink jet print head is driven with print voltage

0001 001 002 003 004 005 006 007 008 009 010 011 012 013 014 015 016 017 018 019 020 021 022 023 024 025 026 027 028 029 030 031 032 033 034 035 036 037 038 039 040 041 042 043 044 045 046 047 048 049 050 051 052 053 054 055 056 057 058 059 060 061 062 063 064 065 066 067 068 069 070 071 072 073 074 075 076 077 078 079 080 081 082 083 084 085 086 087 088 089 090 091 092 093 094 095 096 097 098 099 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000

pulses of approximately 12 V and a duration of approximately 1.9 - 2.3 μ s. A drop of ink is thereby accelerated to the surface of a print medium or, if no print medium is present, to the opening of an ink sump container. The local heating also leads to the gradual rise of the temperature in the broader environment of the heating resistor. A printing pause, in contrast, leads to the gradual drop of the temperature. In particular, an ink jet printer connected to a personal computer that is restarted daily requires too long a preparation time for the printing job. Given 1/2-inch ink jet cartridges, for example, 22 temperature values of the print head that belong to a respective print pulse voltage value are measured after turn-on. Each nozzle is driven one thousand times per measurement with the print pulse voltage value that has been set. In the next measurement, the nozzle is driven a thousand times with a print pulse voltage value that is set lower. The course of the temperature curve measured in this way is interpreted. The print pulse voltage value that is derived is employed for the subsequent printing. The ambient temperature likewise has an influence in the measurement. The preparation time that is thus required then has a predetermined duration of approximately 1 minute.

If, on the other hand, a start could be undertaken proceeding from a standby mode for the ink jet printer, then this could allow an immediate implementation of the print job. The correct operating temperature 15-40°C is retained when the ink jet print head is operated in the standby mode without printing a print medium. The operating temperature can be maintained during printing given a shorter printing pause or in the standby mode by electrically heating the heating resistor close to each nozzle such that hardly any or no water of the aqueous ink evaporates. An energy pulse of approximately 0.75 μ m then suffices only for the warmup (pulse warming-up) but not yet for printing. For achieving a longer service life of the cartridge, the PWU method

(pulse warming-up) also is employed after the turn-on. Given an ambient temperature range of 10-40°C, too, a warmup time must elapse if an operating temperature of approximately 45°C is to be achieved again. A longer time must pass below the indicated range of the ambient temperature. A predetermined operating temperature also can be maintained with a stronger energy pulse that is supplied in time intervals wherein printing is not performed. Although this allows an immediate printing, a stronger energy pulse $>2\mu s$ leads to ink spraying. The ink supply of a cartridge, however, is limited to approximately 42 ml and thus also is consumed in the standby mode. Since the ink cartridges hold a far lower ink volume than, for example, the ink tank of the JetMail® postage meter machine, the service life of the ink cartridge would be considerably shortened by each and every additional ink consumption during warmup.

United States Patent No. 5,625,384 discloses an ink jet printer with replaceable ink print heads, whereby the characteristic data of each specific head are determined during the production of the cartridge and stored in the ROM on the head, i.e. before an initial placement in the ink jet printer. The head operating conditions thus can be automatically called. The replacement of a head is automatically recognized on the basis of identification information. An ink jet head that is re-introduced (re-used), however, cannot be operated with the optimum conditions if too long a time interval has passed before the re-introduction. When the re-introduced ink print head has only a residual ink supply available to it, however, a restoration of conditions that guarantee a long service life of the ink print head could be foregone. However, there is no possibility of shortening the time span after the re-introduction until the renewed

the machine for an ink jet print head that is replaced and reintroduced. Preferably, ink cartridges are utilized that have an ink reservoir, an ink jet print head and a non-volatile memory. Optimum warmup data are determined for different ink cartridges by a control unit of the machine and are stored. Not only the ambient temperature, but also other conditions that can have changed given a later reemployment of an ink cartridge, are inventively taken into consideration. For example, an ink cartridge serial number that has been read out can be stored in the memory of a postage meter machine together with appertaining warmup data given a first-time initialization of an ink cartridge, such data being subsequently adaptable to the changed conditions. Additionally or alternatively, the warmup data can be stored on a memory chip of an ink cartridge.

When optimum warmup data have already been determined, a reduction of the warmup cycles at the next activation can ensue by means of:

- a temperature-related data follow-up by using a table stored in the memory or by a calculation according to an algorithm stored in the memory;
- a history-related data follow-up by using a table stored in the memory or by a calculation according to an algorithm stored in the memory; and/or
- a user-related data follow-up corresponding to a user input of data into the memory and calling operating parameters dependent on the selection made by the user.

When the warmup data for a specific ink cartridge were stored under first conditions upon initialization thereof, then the appertaining warmup data under second conditions at the next activation can be determined without having to repeatedly measure a physical condition. At least the ambient temperature and the head temperature upon activation are included in a current second condition. When the

measured temperature, however, lies between two temperature points in the table, the microprocessor can interpolate in the warmup data. The data follow-up is possible in three combinations:

- temperature-related and history-related follow-up;
- temperature-related and user-related follow-up; as well as
- temperature-related and history-related and user-related follow-up.

A postage meter machine or an ink-jet printer allow a user input via a user interface in order to enter a setting selectable in steps between a longer service life of the cartridge or a faster operational readiness (fast start). The time span after the reintroduction until the renewed operation of each cartridge thus has a selectable length dependent on user wishes, but a shorter selected length reduces the service life of the cartridge. The user-related follow-up is related to the current input request. Given the user-related data, the variation of the temperature behavior of the head of the ink cartridge due to the ambient temperature is also considered.

The completed ink consumption/use of every ink cartridge and the aging are history-related conditions that the postage meter machine automatically takes into consideration. Aging occurs not only due to the time duration over which the head is operated but also occurs given non-use. The manufacturer of the postage meter machine stores an expiration date for the ink cartridge in each of the ink cartridges in non-volatile fashion. For example, an internal calender/clock of the postage meter machine can be employed for determining the aging. Before the expiration date, the value (count) of the calender/clock thereof will reduce due to usage of the ink cartridge. It thus seems justified to implement a faster start at the expense of the service life of the ink cartridge.

A determination also can be made as to whether the expiration date for the ink cartridge has passed. In such a case, the controller is programmed to automatically implement a fast start at the expense of the service life of the cartridge that allows the time span until the renewed operation of the cartridge to be shortened to a minimum length.

As an alternative to the expiration date, a number of days can be stored as a limit value in non-volatile fashion in each of the ink cartridges. This is decremented daily until zero is reached. Upon downward transgression of predetermined limit values of days, or when zero is reached, it is enabled to implement a correspondingly faster start at the expense of the service life of the cartridge.

In a further version of the invention, a number of days is stored in non-volatile fashion as a limit value and a counter is incremented daily until a number of days is reached that corresponds to the limit value. Upon upward transgression of predetermined limit values of days, it is again enabled to implement a correspondingly faster start at the expense of the service life of the cartridge.

The modification of the temperature behavior due to usage and aging of the ink cartridge is taken into consideration by means of the history-related data.

This temperature-related, history-related and/or user-related data follow-up employ warmup data that are allocated to the current condition data, such as in a table. The production thereof ensues with sensors and memories, possibly with a clock/date module. The microprocessor of the controller of the printer device implements a determination of the ambient temperature, of the head temperature, the filling level, the time duration for operation of the head up to the current date, as well as the user request and selects warmup data or calculates warmup data.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a postage meter machine with an ink cartridge therein constructed and operating in accordance with the invention.

Figure 2 is a perspective view of an ink cartridge constructed and operating in accordance with the invention.

Figure 3 is a block circuit diagram of the electronic semiconductor chip for the head constructed and operating in accordance with the invention.

Figure 4 is a block circuit diagram with a contacting unit and the electronic control unit of the printer device constructed and operating in accordance with the invention.

Figure 5 is a temperature/voltage diagram for explaining the invention.

Figure 6 is a flowchart of the data follow-up for warmup cycles of an ink jet print head constructed and operating in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a perspective view of a postage meter machine 1 opened at the top. The postage meter machine 1 has a slot-shaped opening 3 in its housing 4. The transport direction for a supplied piece of mail (not shown) is identified by an arrow and proceeds from the upper left to the bottom right. Given further transport, the piece of mail comes to lie against a guide plate 2 of the postage meter machine 1. The housing 4 opened at the top shows two ½ inch ink jet print heads positioned in printing position.

Each print head has its own data memory and ink store and is therefore also referred to as an ink cartridge. An ink storage container holds approximately 40 ml of ink.

The connection side of the ½ inch ink cartridges 21, 22 is fashioned in a specific, predetermined way. For electronic signal conversion and electromechanical connection, corresponding control and contacting units 211 and 221 are adapted to the connection side of the ½ inch ink cartridges 21, 22, respectively.

Figure 2 shows an ink cartridge 21 that has an electronic semiconductor chip 2100 in a head that is connected to a neck 2103. The head has a nozzle plate 2104 in the ejection direction and -- orthogonally thereto -- a parallel interface with an electrical contacting unit 2105 for the drive of the ink jet print head. The ink cartridge 21 has a belly-shaped ink reservoir 2106 as an ink store and -- lying opposite thereto -- an electronic memory chip 210 for storing warmup data of the ink jet print head 21 with electrical contacts 2107 for interrogating the warmup data, the filling level data and other data. The latter data include a manufacturer identification number on the basis of which the control unit of the printer device can check whether a valid ink cartridge 21 has been installed. A mechanical projection 2108 prevents insertion into the printer or device of ink cartridges that are not authorized by the manufacturer of the printer device. The memory chip 210, the contacts 2107 and the projection 2108 are preferably combined in a structural unit and non-releasably secured (for example, by gluing) to the housing wall of the ink cartridge (at the neck or back). The electronic memory chip 210 for storing warmup data has a serial interface with the electrical contacts 2107 for the interrogation of data. A control and contacting unit 211, which mates with the projection 2108 and the contacts 2107 is provided for electronic signal conversion and mechanical connection to the ½ inch ink cartridge.

Figure 3 shows a block circuit diagram of the electronic semiconductor chip 2100, which at least has a data memory 2102 for the ink cartridge 21, a sensor 2109

for the head temperature and ink ejectors E1...En...E300 in a head 2101. In the bubble jet principle, the ink ejectors respectively contain heating resistors R1...Rn...R300, one heating resistor being allocated to each ink chamber and being driven by respective negators N1, ..., Nn, ..., N300. The negators N1, ..., Nn, ..., N300 are connected to pins for address inputs A1, ..., An, ..., pins for power inputs P1, ..., Pn, ..., and pins for ground potential G1, ..., Gn, ... and can be selected thereby. The pins for ground potential G1, ..., Gn, ... and those for the power inputs P1, ..., Pn, ... are combined into 14 respective groups for a preselection. For example, 22 ink ejectors E262, E264, ..., En, ..., E298, E300 of a head 2101 can be preselected in common via the pins P14 and G14 of the fourteenth group, and 22 ink ejectors E86, E88, ..., Em, ..., E1216, E128 of the head 2101 can be preselected in common via the pins P6 and G6 of the sixth group. The pins for address inputs A1 through A7, A9 through A14 and A16, ..., An, ..., A22 are combined to form 20 address inputs A1, ..., An, ..., A22 that allow the 20 ink ejectors E262, E264, ..., En, E298, E300 of the fourteenth group of the head 2101 to be individually selected. The pins for address inputs A1, ..., An, ... at the other groups are combined to a maximum of 22 address inputs A1, ..., An, ..., A22 in order to be able to individually select the 22 ink ejection means, for example of the sixth group. With 50 contacts of the contacting unit 2105, thus, more than 300 dots can already be addressed. The memory cells of a read-only memory 2102 (ROM) also can be individually addressed via the 22 address inputs A1, ..., An, ..., A22. The word width of the ROM 2102 amounts to 1 bit that can be interrogated via the pins R10x, G6 in order, for example, to interrogate the type (1 bit), the serial number of the ink cartridge (8 bits) and, as needed, other data (13 bits). Each memory cell is constructed similarly to the circuit

for ink ejection. Each cell has a negator with an FET and a drain resistor. The latter is mask-programmed and can be connected in parallel with a reference resistor when the pins G14 and G6 are connected. The interrogation of a resistance reference value ensues via the contact pin R10x when G14 is selected. A further contact pin S is provided for the interrogation of the head temperature sensor. The contacting unit 2105 connected to the head 2101 has a total of 52 contacts (Figure 2).

Figure 4 shows a block circuit diagram with a control and contacting unit 211 (pin drive unit) and the electronic control unit of the printer device. The control unit 14 of the printer device 1 has at least one microprocessor 140, user interfaces 142, 143, a memory 200, a serial interface 144 and a clock/date module 145. For example, the control unit 14 can be for a postage meter machine and also can contain a secure accounting device 141 for reckoning frankings. The control unit 14 is connected to the memory 200. Via a contacting unit 2117 of the control and contacting unit 211, the control unit 14 is connected to the contacting unit 2107 of the memory 210 via a serial interface 144. The memory 210 is, for example, an E²PROM or similar non-volatile write/read memory. The control and contacting unit 211 contains an application-specific integrated circuit (ASIC) 2111 and a temperature sensor 2119 for determining the ambient temperature. The ink jet print head temperature from the sensor 2109 and an 8-bit ink cartridge serial number from the read-only memory 2102 (ROM) can be interrogated via the contacting unit 2115 of a parallel interface of the ASIC 2111 of the control and contacting unit 211. This read-only memory 2102 supplies the 8-bit ink cartridge serial number to the contacting unit 2105 of the parallel interface of the semiconductor chip 2100 that is connected to the contacting unit 2115 of the parallel interface of the ASIC 2111. The

data stored in the memories 200 and 210 are called by the microprocessor 142 and the head temperature determined via the sensor 2109 is interrogated. The ASIC 2111 of the control and contacting unit 211 receives serial signals that are now supplied by the control unit 14 of the printer device 1 so that these can be converted into parallel drive signals for the electronic semiconductor chip 2100. Controlled by the ASIC 2111, a voltage converter (DC/DC) 2112 generates the print voltage at the required amplitude.

A second control and contacting unit 221 (not shown) for the second ink cartridge 22 is fundamentally constructed the same as the control and contacting unit 211 for the first ink cartridge 21.

Alternatively, a common print control unit (not shown) is also possible that contains an ASIC 2011 and a voltage converter (DC/DC) 2012 and to which two contacting units 211 and 221 can be plugged. The common print control unit 20 is driven by the control unit 14. A potential difference between the two ink cartridges 21 and 22 with respect to the drive pulse energy is then compensated with a modified pulse duration given the same pulse amplitude.

In accordance with the inventive method, storage of warmup data under first conditions ensues, and second conditions are determined, and the appertaining warmup data are determined given current second conditions. The E²PROM 210 arranged on the ink cartridge 21, 22 or a comparable non-volatile memory is provided for storing warmup data in a first memory area and the ink cartridge serial number in a second memory area, the latter being identical to the ink cartridge serial number stored in the memory ROM 2102. The microprocessor 140, for example, accesses the first memory area of the memory 200 or 210, with the warmup data using the ink

000440340004
cartridge serial number from the ROM 2102. A manufacturer identification number of the manufacturer supplying the printer device 1 and ink cartridges 21, 22 can be present stored in the memories 200 or 210. The manufacturer identification numbers of all ink cartridges 21, 22 are identical. The authorization to employ the ink cartridges 21, 22 can be checked by the microprocessor 140 on the basis of the manufacturer identification number that is present stored in a memory area of the memory 140. The form of the contacts 2107, the nature of the interface (serial) and the mechanical projection 2108 additionally limit the attempted use of ink cartridges of a different manufacturer without authorization. The correctness of all code or numbers can, for example, be checked by a remote data center. German Patent Application Number 199 58 941 discloses a method for protecting a device against operation with unapproved consumables and an arrangement for the implementation of the method, whereby a code is allocated to the ink cartridge and the check of the authenticity of the ink cartridge ensues in a remote data center on the basis of a stored reference code word.

The storage of warmup data under first conditions ensues in a known way upon initial installation of the ink cartridge, and the check of the authenticity of the consumable (ink cartridge) can be triggered at the same time in a remote data center, namely on the basis of the manufacturer identification number and the 8-bit ink cartridge serial number or, alternatively, on the basis of a code word read out from the memory 210 by comparison to a reference code word stored in a remote data center. The code word can also be formed by encryption of serial and identification numbers or is merely allocated to the serial number. Although the communication with the remote data center can be tapped into, it cannot be

interpreted in order to generate counterfeit ink cartridges with a true ink cartridge serial number and manufacturer identification number.

On the basis of Figure 5, which shows a temperature/voltage diagram, the determination of the warmup data under first conditions given initial installation of the ink cartridge shall now be explained. A precondition is that the ambient temperature ϑ_u measured by the control and contacting units 211, 221 (pin driver unit) lies in the optimum range, and that, after calibration has ensued, the head temperature ϑ_k can be measured by a temperature sensor of the print head. Given $\frac{1}{2}$ inch ink jet cartridges, for example, 22 temperature values of the print head are measured after turn-on, these belonging to respectively predetermined print pulse voltage values. Each nozzle is driven a thousand times with a pulse voltage of ≥ 12 V given an approximately 2 μ s pulse width. The print pulse voltage value is reduced in steps before every further measurement. The measured temperature curve is interpreted by seeking the local minimum of the temperature curve. The appertaining print pulse voltage $U_P(\vartheta_{kmin})$ is multiplied by a factor of 1.3. The optimum print pulse voltage value that derives is employed for the printing and for the warmup. During warmup, however, the pulse width is reduced to approximately 0.75 μ s. The optimum print pulse voltage value and the measured voltage temperature curve are non-volatilely stored. In the aforementioned example, one temperature/voltage curve is stored as 22 measured values in a first memory area upon new installation of an ink cartridge given a parameter (ambient temperature $\vartheta_u = 20^\circ\text{C}$). The ink cartridge is automatically evaluated as new with a further parameter n_0 if history-related data are not yet known. The equations

$$U_{Popt} = 1.3 U_P(\vartheta_{kmin}) \quad (1)$$

$$U_{\text{Popt}} = F\{\vartheta_U, \vartheta_{\text{Kmin}}, n_o\} \quad (2)$$

can be erected for the optimum print pulse voltage U_{Popt} , whereby the function F is determinant for the course of the curve. When other conditions prevail at the next activation (for example, $\vartheta_U = 25^\circ\text{C}$), a renewed measurement of a temperature/voltage curve can be inventively foregone since a U_{Popt} determination is undertaken instead by a data follow-up on the basis of the temperature/voltage curve.

There are two fundamental possibilities for a data follow-up:

- empirically determined data for an optimum print pulse voltage U_{Popt} at different ambient temperatures ϑ_U referenced to first conditions n_o are stored in a Table 1.
- algorithm for calculating the optimum print pulse voltage U_{Popt} given different ambient temperatures ϑ_U referenced to first conditions n_o (see Equation (1)).

Table 1 was registered for a new print head having the serial number 256 and corresponds to the diagram shown in Figure 5. Beginning from a maximum value of 12 V, the voltage is reduced in steps. The step width amounts to 0.2 V. The minimums ϑ_{Kmin} are emphasized with **bold face**.

Table 1

$\vartheta_U \backslash U_{\text{P in V}}$	12	11.8	11.6	...	10.2	...	9.4	8.4	...	8.0
10 °C	42°	41.5°	41°		46°		46°				46.5°		47°
20 °C	48°	47.5°	46°		41°		37.5°				38°		39°
30 °C	55°	54°	52°		46°		43°				40°		40.1°
40 °C	60°	59°	58°		53°		48°				42.5°		42°
$U_{\text{Popt in V}}$					13.2		12.2				10.9		10.4

In the case of empirically determined data and an ambient temperature placed therebetween, intermediate values that are not stored can be determined for the appertaining print pulse voltage by using a standard interpolation calculation. The print pulse voltage belonging to the ambient temperature is multiplied by a factor of 1.3 and yields the optimum print pulse voltage (emphasized with **bold face**).

For a print head that is not new, second conditions are to be additionally determined as a combination of parameters that enable a history-related and user-related adaptation in that further tables are produced dependent on the parameter n_P , O_{user} . The second conditions (print head age, filling level) are expressed by the history-related parameter n_P . In the simplest case, there is one second table since a distinction is only made between new (parameter n_o) and old (parameter n_P). The user-related parameter O_{user} generates a further adaptation for what is still a fast operational readiness. In the simplest case, there is only a third and fourth table, since a distinction is made between only two cases, normal and faster.

Parameter	n_o	n_P	n_o, O_{user}	n_P, O_{user}
Table	1	2	3	4

The flowchart for the data follow-up for warmup cycles of an ink jet print head proceeds from Figure 6. After the start step 100, the control unit 14 preferably reads (step 101) and checks (step 102) the identification number ID of the cartridge manufacturer. A branch is made to the step 104 given a permitted cartridge manufacturer. Otherwise, a branch is made back to the step 101 via step 103 to output an error message. The quality is thus assured since only the cartridges of a specific manufacturer are accepted. A check is carried out in step 104 to determine whether a reinstallation of an ink cartridge should ensue. Ink cartridges that have

already been used and replaced in the interim can also be reintroduced. Warmup data with parameter n_o , the first condition and, possibly, a code word are already stored for such a non-new ink cartridge. The control unit 14 has a security module 141 that is capable of forming a code (word) by encryption of serial number and manufacturer identification number. The code word is stored in the respective memories, such as the memory 210 of the ink cartridges 21, 22. When a code word or the parameter n_o is stored, no reinstallation is undertaken and a branch is made to the step 111 in order to implement a data follow-up for a fast start in following steps. Up to 256 different serial numbers with allocated warmup data and parameters can be stored in a memory 200 of the postage meter machine. The need for memory space can be reduced the more data (code, serial number and allocated warmup data and parameters) there are that are stored in the respective memories of the ink cartridges themselves.

When a new installation is to be undertaken, then the serial number is read first in the step 105 and the generation of a code that is allocated at least to the serial number potentially ensues. After reading the serial number in step 105, a branch is made to step 106 in order to trigger the automatic communication of the code or of the serial number to the telepostage data center TDC. The communication alternatively can ensue later, for example given a communication for the purpose of a recrediting. An acquisition of the consumable that has been introduced and a check of the code of the serial number ensue in the TDC. The ink cartridge of the specific manufacturer with the serial number that has been read must in fact have been supplied to the user. Otherwise, measures for protection against pirated products can be undertaken. Given a new installation, the ambient temperature ϑ_u

is measured and a curve for the head temperature $\vartheta_k = f\{U_p\}$ is determined in the step 107, the latter being a function of the print pulse voltage U_p applied to the heating elements. A minimum of the head temperature ϑ_{kmin} lies in the range $12\text{ V} \geq U_p \dots \geq U_{pmin}$. The print pulse voltage $U_p(\vartheta_{kmin})$ that is allocated to the minimum is determined in step 108. The optimum print pulse voltage is then determined according to the aforementioned Equation (1) and stored in the first memory area of the memory 200 or 210. Storage of the serial number or the code and the first conditions n_o in the second memory area of the memory 200 or 210 ensues in step 109. In the following step 110, a first table for the optimum print pulse voltage is selected dependent on the parameters or generated according to Equation (2).

From step 110, a branch is made via step 104 to step 111, where an interrogation is started as to whether second conditions were newly input. This would not be the case given a new installation, and branch is made to step 113, where an interrogation is started as to whether second conditions are present stored. When a parameter O_{user} to the effect that a fast operational readiness should be produced was input and stored user-related at a previous time, a branch is made to a step 114. This is usually not the case given a new installation and a branch is made to step 116, where warmup data are stored allocated to the serial number of the ink cartridge. A pre-heating with pulses having the duration $t = 0.75\text{ }\mu\text{s}$ and an amplitude U_{popt} can thus be undertaken in step 117. The head temperature repeatedly measured in step 118 is monitored (steps 119, 120). If it is found in step 119 that a minimum of the optimum head temperature has not been downwardly transgressed, a check ensues in step 120 to determine whether a maximum of the optimum head temperature range has been exceeded. If the head temperature lies

within the optimum head temperature range, then the end (step 122) is reached. If, however, the head temperature lies below the optimum head temperature range, then $\vartheta_K > \vartheta_{Koptmin}$ is not true, and a branch is made back to the step 117 for the pre-heating. The warmup pulses lead to a head temperature that rises in steps. Otherwise, an error message ensues (in step 121) if the check in step 120 shows that a maximum of the optimum head temperature range is exceeded (then, $\vartheta_K < \vartheta_{Koptmax}$ is not true). The reduction of the warmup cycles occurs given a used ink cartridge. The invention has the advantage that the warmup cycles with ink spraying of a new installation can be avoided given ink cartridges that are not new. When a method for data follow-up is employed for the warmup cycles, the warmup data U_{Popt} and $t = 0.75 \mu s$ stored in step 116 guarantee a warmup of the print head of a non-new ink cartridge in less than half the time, i.e. within a time of $< 30 s$.

Given a used ink cartridge, the interrogation in step 111 can yield a prompt that a second condition should be newly entered. For example, the user can enter a user-related parameter O_{user} by keyboard. Alternatively, the telepostage data center can enter a parameter O_{user} into the postage meter machine in conjunction with a recrediting and after a successful check of the serial number of the ink cartridge, this parameter O_{user} influencing the warmup time.

If the ink cartridge is a pirated product, then at least the warmup time can be lengthened. Ultimately, only a quality product whose characteristics are known should allow a fast warmup.

In another case, the telepostage data center TDC supplies and enters a parameter for a fast warmup on the basis of a client request. The parameter O_{user} stands for a user-related reduction of the warmup time of the print head. The

warmup data stored in step 116 deviate from the value of the optimum print pulse voltage U_{Popt} with respect to the pulse amplitude. Given a lower pulse amplitude, the service life of the print head of the ink cartridge is lengthened, as is the warmup time of the print head. Given a higher pulse amplitude, the service life of the print head of the ink cartridge is shortened, as is the warmup time of the print head. Fundamentally, the pulse duration can also be varied in addition to the pulse amplitude. It is provided in one version that the parameter O_{user} allows a fast start by varying the pulse duration according to the client request.

The parameters n_p for warmup data of the used ink cartridge are known, i.e. can be queried, or are stored, and a branch is therefore made from step 112 to step 114 via step 113. At least one measurement of the ambient temperature ϑ_U now ensues and, potentially, the measurement of the current head temperature ϑ_K . When all required parameters are known, then step 115 is reached. Either a corresponding table can be selected or the optimum warmup data are computationally generated according to an algorithm. It is possible to apply a mixed method with selection and generation:

- a) The optimum warmup data $U_{Popt}(\vartheta_U)$ are taken from a stored table with measured and partly empirically determined data. The latter and the 2nd conditions are then entered into an equation:

$$U_{Popt3} = F_3\{U_{Popt}(\vartheta_U), \vartheta_K, n_P, O_{user}\} \quad (3)$$

and the pulse duration amounts to $t = 0.75 \mu s$

or the equation reads:

$$U_{Popt4} = F_4\{U_{Popt}(\vartheta_U), \vartheta_K, n_P\} \quad (4)$$

and the pulse duration lies in the range $1.9 \mu s > t(O_{user}) > 0.75 \mu s$ and is selected in conformity with the customer request.

- b) The optimum warmup data are computationally generated according to an algorithm for at least two tables: $U_{Popt1} = F_1\{(\vartheta_U), \vartheta_K\}$, $U_{Popt2} = F_2\{(\vartheta_U), \vartheta_K\}$. One of the tables, for example Table 2, is now available for at least one parameter n_P or O_{user} , and U_{Popt2} can be taken therefrom for a fast warmup.

The parameter n_P refers to history-related data such as, for example, the ink remainder, the filling level, the number of frankings or the operating age since the initial installation or to the expiration date before which the ink should be used. A number of tables thus must be generated or compiled with empirically determined data. One table can then be selected from this number. The current second conditions are described by the ambient temperature ϑ_U , the ink print head temperature ϑ_K and parameters n_P , O_{user} , and the control unit 14 calls the parameter n_P dependent on the use of the ink cartridge and calls the parameter O_{user} dependent on the selection made by the user for a shortened warmup cycle. Given employment of two ink cartridges, these are driven with different warmup data as a result of a different temperature-related or history-related data follow-up.

The invention is not limited to the present embodiments. Modifications are conceivable for generating or selecting a table before the step 116 is subsequently reached in order to store the identified, optimum warmup data allocated to a code or to the serial number of the ink cartridge.

Although modifications and changes may be suggested by those skilled in the art, it is the intention of the inventor to embody within the patent warranted hereon

all changes and modifications as reasonably and properly come within the scope of
his contribution to the art.

090404 090404